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Devices and Methods for Sensing Nitric Oxides

Nitric species such as nitric oxides are important environmental pollutants as well as key breath biomarkers of respiratory diseases. A chemical sensor that can quickly, selectively and sensitively detect these analytes will find applications not only in environmental monitoring, but also as a non-invasive medical diagnosis and management device. Current detection methods are divided into two categories: lab-based analytical methods, including various chromatographic and spectroscopic techniques, and handheld or portable chemical sensors. Lab-based analytical methods are well established and have been used as the most reliable way to detect unknown analytes, but they are slow, expensive and bulky. Chemical sensors in the second category are simple, miniaturized and low cost, but have challenges with sensitivity, selectivity and reliability in complex matrices such as breath.

Researchers at the Biodesign Institute of Arizona State University have developed novel devices for detection of nitric oxides and their reaction products that have improved selectivity and reliability. These devices can perform in two different ways having either independent or combined electrochemical and optical detection. In the combined detection device, two working electrodes are covered by an electrolyte containing chemical probe that produces a color change when in contact with nitric oxides. The two working electrodes and electrolyte are combined with an optical detector that records the subsequent color change. In the independent detection device, two working electrodes covered by an electrolyte produce a color change as well, but the optical detection is performed on a separate all-solid state detector capable of selectively developing color when it comes in contact with a flow of gas containing nitric oxides. This configuration allows for the determination of nitric oxides in completely independent ways and based on different principles so that selectivity can be tuned by using different chemical reactions for each of the sensing elements. Both devices also utilize a low back pressure mouthpiece that conditions a sample with an oxidizing and humidity reducing filter making it easier to use, especially for users with limited lung capacity. Further, a software application was written to allow the devices to communicate with smart phones or other electronic devices to analyze data and display and store results.

These devices represent a novel and powerful sensing platform that is capable of selectively detecting nitric oxides and communicating those results to a personal electronic device for non-invasive health monitoring and management.

Potential Applications

- Environmental pollutant monitoring
- POC disease monitoring and management: asthma, pulmonary disease, allergic airway inflammation, and other respiratory diseases
- Personal exposure monitoring

Benefits and Advantages

- The mouthpiece can condition breath at a flow of 50 ml/sec with an associated error of ±10% with back pressure less than 4 cm H2O
- Low ppbV and ppmV detection limits
- Real-time detection of analytes
- Improved selectivity and reliability compared to single detection devices
- Can be used by people with limited lung capacity
- Broadly patented both domestically and internationally
- Compact form factor that is both portable and low cost
- High integration with HTP fabrication processes
- Decreased false positive and negatives responses of the sensor
- Simultaneous detection of distinctive gasses

For more information about this opportunity, please see

Zhao et al – Sens Actuators B Chem - 2014

Prabhakar et al – Anal. Chem 2012

Prabhakar et al – Anal. Chem 2010

For more information about the inventor(s) and their research, please see

Dr. Tao's departmental webpage

Dr. Forzani's departmental webpage